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Planck intermediate results: V. Pressure profiles of galaxy clusters from the Sunyaev-Zeldovich effect

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Abstract

Taking advantage of the all-sky coverage and broadfrequency range of the Planck satellite, we study the Sunyaev-Zeldovich (SZ) and pressure profiles of 62 nearby massive clusters detected at high significance in the 14-month nominal survey. Careful reconstruction of the SZ signal indicates that most clusters are individually detected at least out to R500. By stacking the radial profiles, we have statistically detected the radial SZ signal out to 3 × R500, i.e., at a density contrast of about 50-100, though the dispersion about the mean profile dominates the statistical errors across the whole radial range. Our measurement is fully consistent with previous Planck results on integrated SZ fluxes, further strengthening the agreement between SZ and X-ray measurements inside R500. Correcting for the effects of the Planck beam, we have calculated the corresponding pressure profiles. This new constraint from SZ measurements is consistent with the X-ray constraints from XMM-Newton in the region in which the profiles overlap (i.e., [0.1-1] R 500), and is in fairly good agreement with theoretical predictions within the expected dispersion. At larger radii the average pressure profile is slightly flatter than most predictions from numerical simulations. Combining the SZ and X-ray observed profiles into a joint fit to a generalised pressure profile gives best-fit parameters $[P0,c500,\gamma, \alpha,\beta] = [6.41,1.81,0.31,1.33,4.13]$. Using a reasonable hypothesis for the gas temperature in the cluster outskirts we reconstruct from our stacked pressure profile the gas mass fraction profile out to 3 R500. Within the temperature driven uncertainties, our Planck constraints are compatible with the cosmic baryon fraction and expected gas fraction in halos. © 2013 ESO.

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Keywords

Cosmology: observations, Galaxies: clusters: general, Galaxies: clusters: intracluster medium, Submillimeter: general, X-rays: general